



P-ISSN: 2349-8528  
 E-ISSN: 2321-4902  
[www.chemijournal.com](http://www.chemijournal.com)  
 IJCS 2020; 8(4): 3814-3817  
 © 2020 IJCS  
 Received: 15-05-2020  
 Accepted: 10-06-2020

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## Growth and yield attributing characters of chickpea varieties as influenced by altering plant rectangularity by varying plant spacing

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DOI: <https://doi.org/10.22271/chemi.2020.v8.i4av.10241>

### Abstract

A field experiment was carried out during *rabi* season of 2017-18 and 2018-19 on chickpea to assess the growth and yield of chickpea variety (PG 186, PG 4 and PG 5) and plant spacing/ rectangularity 5 cm (0.16), 10 cm (0.33), 15 cm (0.5) and 20 cm (0.66). The results revealed that the chickpea variety PG 5 recorded significantly higher grain yield of 1820 and 2806 kg/ha, respectively, during 2017-18 and 2018-19 which was found significantly superior to PG 4 and PG 186. The significantly highest grain yield (1943 and 2689 kg/ha respectively, during 2017-18 and 2018-19) was obtained by chickpea at closer plant spacing of 5 cm (0.16 rectangularity) over rest of the plant spacings/ rectangularities. Though the number of pods, grain yield per plant and 100 grain weight were found maximum at wider plant spacing of 20 cm (0.66) but it could not compensate the yield loss due to less plant population in wider plant spacing.

**Keywords:** chickpea, varieties, plant spacing, yield

### 1. Introduction

Pulses hold prime position in Indian Agriculture. They are one of the important constituents of the Indian diet and supply a major part of the protein requirement to vegetarian masses. India is the largest producer (25% of the global production), consumer (27% of the world consumption), and importer (14%) of pulses in the world. Pulses are grown in *kharif* as well as *Rabi* seasons, but *rabi* pulses contribute more than 60% of the total production. India is the largest producer, consumer and importer of pulses in the world.

Chickpea is one of the most important pulse crop grown in semi-arid and tropical climate. Among the different agronomic practices limiting the yield, choice of a suitable geometry and population for a particular genotype is one of the important factors. Adaptation of proper planting geometry to a particular genotype will go a long way in making efficient use of limited growth resources and thus to stabilize yield. In recent years, the development of various small and bold seeded chickpea varieties have shown the possibilities of chickpea cultivation under late planting conditions in command or rice-fallow areas. Evaluation of these varieties under late planting conditions will be of great importance. For raising the production of chickpea, varietal response may vary to a great deal particularly with respect to seed rate and row spacing arrangement as late planted crop has less vegetative growth.

Chickpea, like other crops, competes for resources as light, nutrient and water. Light is one of the most important factors affecting agricultural as the growth is governed by the ability of a crop to intercept light and to convert the intercepted light into biomass (Confalone *et al.*, 2010)<sup>[2]</sup>. Moreover, dry matter production of a crop is linearly related to the amount of solar radiation intercepted by the crop under stress-free environments (Tesfaye *et al.*, 2006)<sup>[9]</sup>.

The solar radiation, used for photosynthesis, can be exploited more especially in chickpea genotypes with non-horizontal leaves, resulting in more yield per unit area if optimum plant density is achieved. The plant density above the optimum not only decreases the seed yield of the crop because of inter-plant competition but also cause wastage of seed. Furthermore, net photosynthesis is decreased at the dense foliage because of lacking solar radiation of basal leaves. On the other hand, the sparse densities cause the seed yield per unit area to decrease and also promote growth and development of weeds. Therefore, determination of optimum

plant density can lead to more effective usage of incident solar radiation for photosynthesis because of a linear relationship between yield and dry matter production (Miah *et al.*, 2003) [6] and long canopy duration.

Thus, the plant rectangularity, one of the important crop density characters, can be manipulated either by varying row or plant spacing or by both to attain the maximum production from unit land area. The space requirement to individual plant depends on variety, its growth habit and agro climatic condition. The seed yield of chickpea is highly dependent on plant population. Seed yield increases with decreased plant spacing upto an optimum limit which changes according to genotypes. It was felt necessary to study the Growth and yield of chickpea varieties as influenced by altering plant rectangularity by varying plant spacing.

## 2. Materials and Methods

A trial was conducted during rabi season of 2017-18 and 2018-19 at Norman E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, District Udham Singh Nagar, Uttarakhand (India). The experiment was laid out in Factorial Randomized Block Design with three replications. The treatment consist of three varieties (PG 186, PG 4 and PG 5) and four plant spacing/rectangularity 5 cm (0.16), 10 cm (0.33), 15 cm (0.5) and 20 cm (0.66) and crop was sown at a constant row spacing of 30 cm. The soil of the experimental site was silty clay loam in texture being medium in available nitrogen (315.2 and 321.6 kg/ha), high in available phosphorus (26.6 and 27.8 kg/ha), medium in available potassium (261.2 and 267.3 kg/ha), and high in organic carbon (0.83 and 0.87 %) contents with neutral in reaction (pH 7.30 and 7.46) in 2017-18 and 2018-19, respectively. The recommended dose of fertilizer was applied with basal application of 18 kg N, 48 kg P<sub>2</sub>O<sub>5</sub> and 24 kg K<sub>2</sub>O per ha through NPK mixture (12:32:16) in all experimental plots uniformly, just before sowing. The seed of all the varieties were treated with thiram @ 2 g+ carbendazim @1g/kg seed, just before sowing. Other agronomical operations were carried out as per recommendation. The observations on growth, yield attributes and yield were recorded at the time of harvest of crop.

## 3. Result and Discussion

### 3.1. Growth

The effect of chickpea varieties as well as plant rectangularity was significant in terms of growth parameters like plant height as well as number of branches per plant. Chickpea variety PG 5 produced the tallest plant (Table 1) and found significantly superior to PG 4 and PG 186. The plant spacing/rectangularity of 5 cm (0.16) produced the tallest plant as compared to the plant spacing of 15 and 20 cm. However, it was at par with 10 cm plant spacing in respect of plant height during both the years. The wider plant spacing of 15 cm and 20 cm resulted in smaller plant (56.6 cm, 56.8 cm and 54.1

cm, 54.2 cm, at harvesting during 2017-18 and 2018-19, respectively) because of having more area between the plants showing more lateral expansion than the vertical one. Similar results were also reported by Chaitanya and Chandrika (2006) [1] also reported that narrow spacing produced tallest chickpea plants indicated competition.

The number of branches per plant was significantly affected by chickpea varieties and plant spacings/ rectangularities. Variety PG 5 produced the maximum number of branches and found significantly superior to PG 186 and remained at par with PG 4 during both years. Number of branches per plant decreased with subsequent decrease in plant spacing. Significantly higher number of branches per plant was recorded in 20 cm plant spacing than other spacings except 15 cm plant spacing. The lowest number of branches per plant was recorded in plant rectangularity of 0.16 during both the year.

### 3.2. Yield Attributes

#### 3.2.1 Number of Pods per Plant

The number of pods per plant recorded in chickpea variety PG 5 (48.1 and 86.6) was significantly superior to that of other varieties. The lowest number of pods per plant was recorded by PG 186 (35.2 and 57.7). Among all the chickpea varieties, PG 5 recorded higher number of pods per plant which was 16.9 and 25.8 per cent over PG 4 and 25.9 and 50.1 per cent over PG 186 during 2017-18 and 2018-19, respectively. Increasing plant spacing/rectangularity significantly increased number of pods per plant. The wider plant spacing resulted in more number of pods per plant. The plant spacing of 20 cm, produced the highest number of pods per plant (50.5 and 86.0) which was significantly superior to the other plant spacings. The variation recorded in number of pods per plant among all the plant spacings/ rectangularity differ significantly during both the years.

**Table 1:** Growth parameters at maturity as influenced by chickpea variety and plant spacing spacings/rectangularity during 2017-18 and 2018-19.

| Treatment                                 | Growth parameters at maturity stage |         |                       |         |
|---|-------------------------------------|---------|-----------------------|---------|
|   | Plant height (cm)                   |         | No of branches/ plant |         |
| Variety                                   | 2017-18                             | 2018-19 | 2017-18               | 2018-19 |
| PG186                                     | 55.3                                | 55.4    | 7.5                   | 7.9     |
| PG4                                       | 57.6                                | 57.8    | 9.1                   | 9.8     |
| PG5                                       | 60.3                                | 60.4    | 9.6                   | 10.2    |
| SEm±                                      | 1.1                                 | 1.2     | 0.2                   | 0.2     |
| CD (P=0.05)                               | 3.4                                 | 3.4     | 0.5                   | 0.7     |
| Plant spacing (cm) / Plant rectangularity |                                     |         |                       |         |
| 5 (0.16)                                  | 61.1                                | 61.3    | 7.5                   | 8.1     |
| 10 (0.33)                                 | 59.2                                | 59.3    | 8.4                   | 8.9     |
| 15 (0.5)                                  | 56.6                                | 56.8    | 9.3                   | 9.8     |
| 20 (0.67)                                 | 54.1                                | 54.2    | 9.8                   | 10.5    |
| SEm±                                      | 1.3                                 | 1.3     | 0.2                   | 0.3     |
| CD(P=0.05)                                | 3.9                                 | 3.9     | 0.6                   | 0.8     |

**Table 2:** Yield attributing characters and yield as influenced by chickpea variety and plant spacings spacings/ rectangularity during 2017-18 and 2018-19.

| Treatment   | Yield attributing characters |         |            |         |                      |         |                       |         | Grain yield (kg/ha) |         |
|-------------|------------------------------|---------|------------|---------|----------------------|---------|-----------------------|---------|---------------------|---------|
|             | No of pods/plant             |         | Grains/pod |         | 100 grain weight (g) |         | Grain yield/plant (g) |         | 2017-18             | 2018-19 |
| Variety     | 2017-18                      | 2018-19 | 2017-18    | 2018-19 | 2017-18              | 2018-19 | 2017-18               | 2018-19 | 2017-18             | 2018-19 |
| PG186       | 35.2                         | 57.7    | 1.82       | 1.70    | 17.19                | 15.95   | 9.10                  | 13.60   | 1293                | 1615    |
| PG4         | 41.2                         | 68.8    | 1.32       | 1.47    | 18.29                | 18.72   | 11.50                 | 16.50   | 1571                | 2387    |
| PG5         | 48.2                         | 86.6    | 1.23       | 1.24    | 26.32                | 25.00   | 15.42                 | 19.25   | 1820                | 2806    |
| SEm±        | 0.7                          | 1.2     | 0.06       | 0.03    | 0.37                 | 0.34    | 0.33                  | 0.52    | 47                  | 73      |
| CD (P=0.05) | 2.2                          | 3.6     | 0.19       | 0.10    | 1.09                 | 1.01    | 0.97                  | 1.55    | 138                 | 215     |

| Plant spacing (cm)/Plant rectangularity |      |      |      |      |       |       |       |       |      |      |
|---|------|------|------|------|-------|-------|-------|-------|------|------|
| 5 (0.16)                                | 32.8 | 51.3 | 1.33 | 1.07 | 19.36 | 18.36 | 8.40  | 12.40 | 1943 | 2689 |
| 10 (0.33)                               | 38.5 | 71.1 | 1.36 | 1.38 | 20.13 | 19.14 | 10.96 | 15.40 | 1647 | 2439 |
| 15 (0.5)                                | 44.4 | 75.7 | 1.49 | 1.58 | 20.74 | 20.39 | 12.76 | 17.64 | 1443 | 2283 |
| 20 (0.67)                               | 50.5 | 86.0 | 1.64 | 1.84 | 22.18 | 21.67 | 15.91 | 20.36 | 1213 | 1667 |
| SEm±                                    | 0.8  | 1.4  | 0.07 | 0.04 | 0.43  | 0.39  | 0.38  | 0.61  | 54   | 84   |
| CD(P=0.05)                              | 2.5  | 4.1  | 0.22 | 0.12 | 1.26  | 1.16  | 1.12  | 1.79  | 160  | 248  |

recorded by PG 186 (35.2 and 57.7). Among all the chickpea varieties, PG 5 recorded higher number of pods per plant which was 16.9 and 25.8 per cent over PG 4 and 25.9 and 50.1 per cent over PG 186 during 2017-18 and 2018-19, respectively. Increasing plant spacing/rectangularity significantly increased number of pods per plant. The wider plant spacing resulted in more number of pods per plant. The plant spacing of 20 cm, produced the highest number of pods per plant (50.5 and 86.0) which was significantly superior to the other plant spacings. The variation recorded in number of pods per plant among all the plant spacings/rectangularity differ significantly during both the years.

### 3.2.2 Number of grains per pod

The number of grains per pod in variety PG 186 (1.82 and 1.70) was significantly superior to that of other varieties. While variety PG 5 (1.23 and 1.24) resulted into the least number of grains per pod during both the years. Among the plant spacing, the wider plant spacing of 20 cm produced the maximum number of grains per pod, which showed its supremacy significantly over the other plant spacing.

### 3.2.3 100-grain weight

It was noticed that 100 grain weight was higher in crop sown during 2017-18 which was 3.6 per cent more over crop sown on 2018-19. The 100-grain weight was affected significantly due to different chickpea varieties and plant spacings. Chickpea variety PG 5 (26.32 and 25.00 during 2017-18 and 2018-19, respectively) recorded the boldest seeds and was significantly superior to other varieties. The highest value of test weight was recorded in plant spacing of 20 cm, which was significantly superior to other plant spacings. The grain weight under plant spacing of 5 and 10 cm did not record significant variation in 100 grain weight during both the years.

### 3.2.4 Grain yield per plant

The maximum grain yield per plant was recorded in variety PG 5, which was significantly superior to other varieties and the plant spacing of 20 cm, produced the highest grain yield per plant, which was significantly superior to the other plant spacings. The grain yield per plant was decreased with subsequent decrease in plant spacing/rectangularity. The lowest grain yield per plant was recorded with closer plant spacing of 5 cm during both the years.

Number of pods per plant, grains per plant and 100-grain weight increased significantly under wider plant spacing (Table 4.12). At closer plant spacing, number of plants accommodated per unit area were more and probably due to more inter plant competition for environmental resources resulted in lower number of pods per plant, Grains per pod and 100-grain weight. Similar result was also reported by Shamsi (2010) [8].

### 3.3. Grain yield

The grain yield per hectare was affected significantly due to different chickpea varieties and plant spacing of chickpea.

Among the chickpea varieties, PG 5 (1820 kg/ha and 2806 kg/ha) out yielded PG 4 and PG 186, which produced the grain yield of 1571 kg/ha, 2387 kg/ha and 1293 kg/ha, 1615 kg/ha, respectively, during 2017-18 and 2018-19, respectively. Which could be attributed to higher number of branches per plant, number of pods per plant and 100 grain weight. Moreover, the survival of plants per hectare was also higher in PG 5 (Table 4.1). The combined effect of higher yield per plant and higher population lead to yield differences to reach the level of significance. Similar findings have been observed by Kaya (2010) [4] and Uttamrao *et al.* (2018) [10]. Among the various plant spacings, sowing of seeds at 5 cm distance out yielded (1943 kg/ha and 2689 kg/ha) remaining the plant spacings. The grain yield recorded under plant spacings of 10 and 15 cm did not differ significantly during 2018-19. The lowest grain yield of chickpea (1213 kg/ha and 1667 kg/ha) was observed at wider plant spacing of 20 cm during both the years. These results are in agreement with the results reported by Rampyare and Dwivedi (2005) [7], Fallah (2008) and Mansur *et al.* (2009) [5].

### 4. Conclusion

With the results obtained during the course of investigation it could be concluded that the wider plant spacing of 20 cm resulted in maximum values of growth and yield attributing characters. But crop sown with closer plant spacing of 5 cm produced the higher grain and biological yield. Thus, chickpea variety PG 5 sown at plant spacing/ rectangularity of 5 cm (0.16 rectangularity) could be recommended for higher yield in *tarai* region of Uttarakhand.

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